THE DIFFERENTIAL RENT OF FARM LAND.

It is a matter of common observation that, owing to differences in the chemical and physical properties of the soil, in the temperature and humidity of the climate, and in the distance from the central market, all farm land is not equally productive. No less familiar is the fact that some farms command a higher rent per acre than others. For a century or more it has been generally recognized that a close relation exists between productivity and rent. According to the text-books on political economy which are generally used in America to-day, rent varies in the same ratio as difference in productivity. By differences in productivity are usually meant differences in the value of the product of different farms of equal areas when cultivated with the same degree of intensity. "Rent," says Walker, "arises out of differences existing in the productiveness of different soils under cultivation at the same time, for supplying the same market. The amount of rent is determined by the degree of those differences. Specifically, the rent of any piece of land is determined by the difference between its annual yield and that of the least productive land actually cultivated for the supply of the same market, under equal applications of labor and capital."*

In this statement of the theory of rent two important factors are left out of account. It is apparently assumed that all farmers possess the same degree of efficiency, and that all land is cultivated with the same degree of intensity or else that variations in these respects do not make it necessary to modify the statement that differential rents are measured by differences in productivity. It is the purpose of this paper to consider the influence of variations in the efficiency of farmers and in the intensity of culture upon the amount of rent which will be paid for the use of land,

* F. A. Walker, *Political Economy*, p. 197.

and to point out that because of these variations differential rent cannot be measured in terms of differences in productivity.

Let us first turn our attention to variations in the efficiency of farmers and the way in which these variations make it necessary to modify the statement that rents vary in the same ratio as differences in productivity. (For the sake of simplicity, it will be assumed in this part of the discussion that the same degree of intensity of culture exists throughout the territory under consideration.) There are more than five million farmers in the United States. From general observations we know that some of these farmers can scarcely make a living, others live comfortably and gradually save enough to buy a small farm, while still others are very prosperous, living well and accumulating considerable sums of money from year to year. The relative degree of prosperity to which the American farmer can attain is determined largely by his own efficiency. By the efficiency of a farmer is meant his capacity to turn off work and to manage a farm. With equal opportunities some men can win a much greater return than others. Those who can produce a relatively large return are called the more efficient farmers, and those who produce a relatively small return are called the less efficient farmers.

We may speak of the qualitative and the quantitative efficiency of a farmer. In this paper we are interested in differences in qualitative efficiency. When two farmers employ equal amounts of labor and capital upon equal areas of equally productive land, the one who possesses a relatively high degree of qualitative efficiency can produce a larger return than his competitor who is qualitatively less efficient. This larger return is won by the farmer who is qualitatively more efficient because he shows greater skill in performing his work or uses better judgment in planning his farm operations, in regulating his field system, in selecting seeds, in choosing tools and machinery with which to do his work, or in the breeding and feeding of

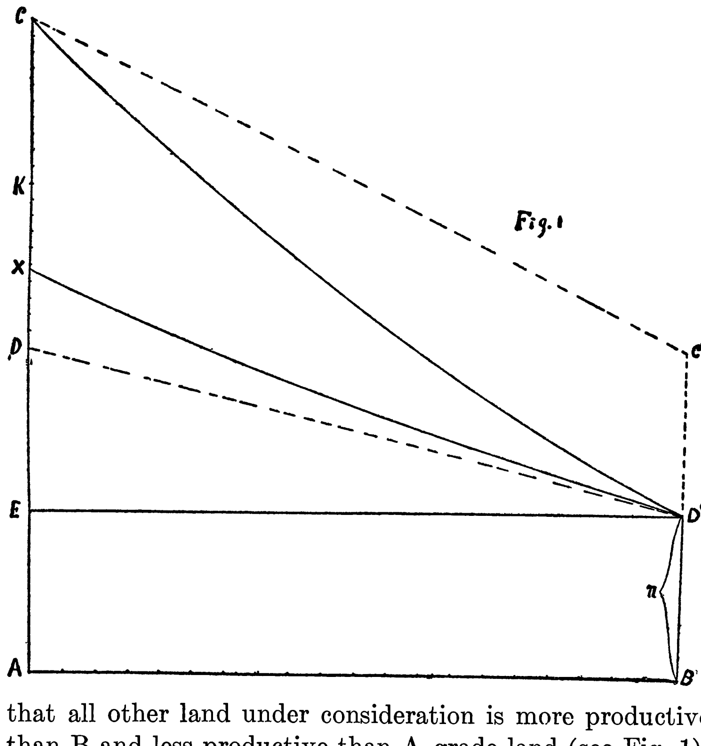
stock. The farmer who is quantitatively more efficient can do more work of a given quality.

Variations in efficiency have long been recognized by all who observe industrial society, but the influence of these variations upon the amount of rent which will be paid for the use of land seems to have been overlooked by the economists who have written upon the subject of rent. The conclusion to which a study of this question leads will first be stated in a few words and then further elaborated.

While the farmers who possess a relatively high degree of qualitative efficiency can win a larger return from land of any grade than can their less efficient competitors, this extra product due to superior ability is greater on the more productive than on the less productive land; and for this reason the more efficient farmers compete only for the more productive land, and pay more for it than the less efficient farmers can afford to pay. If, therefore, we measure differences in productivity in terms of the differences in the value of the products which the least efficient or marginal farmers could produce on the various grades of land under comparison, differential rents will be greater than differences in productivity. Inasmuch, however, as competition among the more efficient farmers for the more productive grades of land leads to a distribution of the land among the farmers in accordance with their efficiency,—the most efficient farmers possessing the most productive and the least efficient the least productive land in use,—the differences in the actual yield of the different grades of land are greater than the differences in the yield which any given farmer could produce; and, since the better farmers could win, and retain as personal profits, an extra product on the marginal land above what the marginal farmers can produce on such land, and must be allowed a profit equally large on the better land to keep them from outbidding the marginal farmers for marginal land and driving them out of the farming business, the differential rent will be less than the actual difference in the value of the product of the more productive

and that of the marginal land. Hence the differential rent of land cannot be measured in terms of differences in productivity.

Let us suppose that the land which is necessary to supply the demand for a certain class of agricultural products, such, for example, as the products of the diversified agriculture of the corn belt, varies in productivity from A to B, that A grade land is twice as productive as B grade land, and



that all other land under consideration is more productive than B and less productive than A grade land (see Fig. 1). Suppose, also, that all the farmers who are able to compete for the use of this land at a given time vary in efficiency from C to D (as represented in Fig. 1), that the farmer who has C degrees of efficiency is qualitatively twice as efficient as the one who possesses D degrees of efficiency, and that

the other farmers are graded according to their efficiency from C to D, as the land is graded from A to B. The farmer who possesses C degrees of efficiency can produce twice as much on land of any grade as the farmer with D degrees of efficiency. The D grade farmer is the marginal farmer, and must receive enough on marginal land to cover costs, including a living. On the A grade land, which is twice as productive as the marginal land, he can produce twice as much with the same outlay, and is willing to pay a differential rent for it equal to one-half the product.

Let us say that the D grade or marginal farmer's product on B grade land is valued at n (represented by line B D′ in Fig. 1), that his product upon A grade land is valued at $2n$ (represented by line A D), and that he is willing to pay a differential rent of n (line E D) for the use of A grade land. Then the value of the product of the C grade farmer, who is qualitatively twice as efficient as the marginal farmer, will be $2n$ (line B C′) on B grade land and $4n$ (line A C) on A grade land. Thus, while the C grade farmer can win an extra product valued at n (line D′ C′) on B grade land, his extra product on A grade land, above what the D grade farmer could produce, is valued at $2n$ (line D C). Hence the C grade farmer will not compete for B grade land until the rent on A grade land rises sufficiently to absorb half of this extra product, so that his personal profit will be the same on both pieces of land. Until rent rises to $2n$ on A grade land (that is, to point K in Fig. 1, and measured by line E K), the personal profit which the C grade farmer can win on such land will be greater than that which he could win from B grade land. If the differential rent of A grade land should rise to $2n$ (that is, to point K), the C grade farmer's personal profit on A grade land (represented by line K C) would be the same as that which he could win on B grade land (represented by line D′ C′), being valued at n in either case. But, while the C grade farmer will pay a rent of $2n$ for A grade land rather than farm marginal land, the D grade farmer will take marginal land rather

than pay more than n for A grade land. With the given hypothesis the differential rent of A grade land will not be less than n (measured by line E D), for the D grade farmer can afford to pay that much for its use. It will not rise higher than $2n$ (measured by line E K), for the C grade farmer would then prefer marginal land, for which no economic rent is charged.

With all grades of farmers competing for the use of land, the differential rent of A grade land will be greater than n; for, at a rent of n, all but the marginal farmer will prefer it to inferior land, because the extra product, due to superior qualitative efficiency, is greater on the more productive land. Each farmer seeks to win the largest possible personal profit; and, as a result of competition for the better land, rent will rise, until one by one the less efficient farmers find it preferable to take less productive land at a lower rent. The most efficient farmer can pay more for the best land than any of his competitors can afford to pay, and still receive a larger personal profit for his superior efficiency than he would receive from the less productive land at the lower rents which the less efficient farmers pay. Differential rents will, for this reason, be greater than the differences in productivity when we measure productivity in terms of the value of the product which the land will yield when farmed by the marginal farmer.

When each farmer has taken the land for which his degree of efficiency enables him to compete to best advantage, the marginal farmer will be found upon marginal land, the average farmer upon average land, and the most efficient farmer upon the most productive land. The product resulting from this most economical application of efficiency to productivity will be measured by the area A C D′ B (Fig. 1). It will be noticed that the line C D′ is not a straight line. This is not a straight line because its distance from the line A B is determined by multiplying productivity by efficiency, both of which are decreasing factors as we go from the most productive to the marginal land. With

regular and infinitely close gradation of land and of farmers, this line would tend to become a regular curve. This curve will probably be irregular, however; for the continuous and regular gradation of land and of farmers which would be necessary to produce a regular curve, gradually falling from C to D′, could, perhaps, never be found.

The line X D′, which may be called the rent curve to distinguish it from the product curve C D′, is drawn arbitrarily to illustrate the way in which rent will rise above line D D′. Point X will be some place between D and K, because, as has been shown, the differential rent of A grade land can neither be less than n nor more than $2n$. With continuous and regular gradation of land and of farmers this rent curve would be regular, but with irregular gradation of either factor it will be irregular. Thus the area E D D′ (Fig. 1) represents the differential rent where all farmers have the same degree of efficiency as the marginal farmer, and the area D X D′ represents the further differential which arises from variations in the efficiency of the farmers. These two constitute the differential rent which would be paid under the conditions laid down at the beginning of this discussion; namely, equal amounts of labor and capital on all grades of land and perfect competition.

The remainder of the surplus represented by area X C D′ goes to the farmers as personal profits, the amount of personal profit received by a given farmer depending upon his relative degree of efficiency.

In this illustration we have considered competition in but one kind of agriculture. The most efficient farmer in one branch of agriculture may be less efficient in another. The best shepherd may be a poor market gardener and *vice versa*. The shepherd will be able to win his largest surplus on cheap lands, while the market gardener can do best on expensive lands near the market. Yet the general principle holds that the best shepherd can win the largest personal profit on the best sheep lands and the best market gardener on the land best suited to his particular business.

Indeed, it would seem that this principle may be applied quite generally, and that it explains why the more efficient men in all lines of economic activity are able to outbid the less efficient for the better instruments of production and for the better grades of labor.

Let us next consider the influence upon differential rents of variations in the intensity of culture. All grades of land are not cultivated with the same degree of intensity. The more productive land is usually cultivated more intensively than the less productive. More units of labor and capital can be applied to it with profit, and all of this extra labor and capital, except the final increment, yields a surplus which may be drawn upon as rent.* Hence, even though all farmers possessed the same degree of efficiency, the amount of rent paid for the different grades of land would not vary in the same ratio as differences in the value of the product which a given amount of labor and capital would produce on equal areas of these different grades of land.†

To make this point clear, it will be necessary to present in a somewhat modified form the subject of intensity of culture and diminishing returns. In the ordinary treatment of this subject, two questions which are essential to the present discussion are omitted. The first of these questions pertains to the degree of intensity which will prove most profitable, the second to the influence of the payment of rent upon the degree of intensity which will yield to the farmer the largest net return.

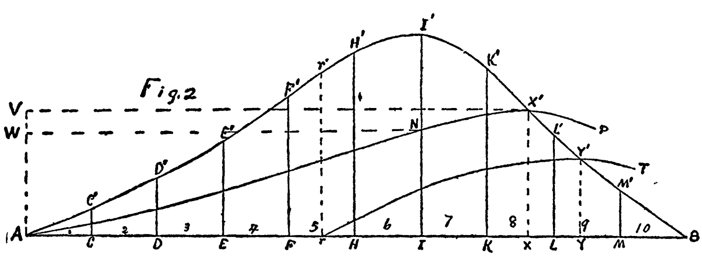
What degree of intensity is most profitable? How much labor and capital should be applied to an acre of land in the production of corn, or in the production of oats, or any other crop, in order that the farmer may win the largest net

*Ricardo, Section 26; McCulloch's Notes to A. Smith's *Wealth of Nations*, Note III.

†Since writing this paper, my attention has been called to a short article by R. P. Falkner, in the *Annals of the American Academy*, vol. xii. p. 89, entitled "Some Aspects of the Theory of Rent," which discusses this same point.

return? This is a question of first importance; for, if too much is expended, the net return will be cut down, and, if too little is employed, the net return will not reach the maximum. There is always some degree of intensity which will yield the largest net return. But what is that degree of intensity?

For the sake of simplicity, let us first suppose that the farmer can get as much land of a given grade as he may want to use, without paying anything for it. Under such circumstances, how much labor and capital should he expend upon each acre of land? It is obvious that in the production of corn, for example, the application of one dollar's worth of labor and capital to an acre of land will ordinarily produce very little, if any, corn at all. It is possible that two dollars' worth will produce a small crop;



but, then, the third dollar's worth will increase the product more than the second, the fourth more than the third, and so on until the point of stationary returns has been reached, after which the succeeding units continue for a time to add to the total product; but these succeeding units are less and less productive, until a point may be reached where further applications will add nothing to the total product. Thus the returns to succeeding units of labor and capital in agricultural production follow the law of increasing returns until the point of stationary returns has been reached, after which the law of diminishing returns operates.

This may be illustrated by means of a diagram. In Fig. 2

the units of labor and capital applied to a given acre of land are measured on the line A B, commencing at A. The line A I′ B represents the increasing and diminishing returns per succeeding unit. Having in mind land with a given degree of productivity, the distance between lines A B and A I′ B will depend upon the degree of qualitative efficiency possessed by the farmer who applies the labor and capital. For this reason it will be necessary to keep in mind a *given farmer*, as well as a given piece of land. When a given farmer employs labor and capital upon a given grade of land, we may speak of the area A C′ C (Fig. 2) as representing the product of the first unit of labor and capital expended, and of the area C C′ D′ D as representing the product of the second unit, and so on for the succeeding units. As illustrated in Fig. 2, the product of each succeeding unit is greater than the one preceding it until six units have been expended, after which each succeeding unit may be said to yield a smaller product than the one immediately preceding it.

With this illustration (Fig. 2) before us, suppose the farmer has one thousand units of labor and capital to expend in agricultural production. With free land at his disposal, how many acres will he use and how many units will he employ upon each acre? Will he apply five units of labor and capital per acre, and use two hundred acres of land? No, his capital will produce a greater *total product* when he applies six units to each acre and confines himself to one hundred and sixty-six and two-thirds acres. But will this make his labor and capital *most* productive? At the first thought one would say yes, because the seventh unit is less productive than the sixth; but, upon looking more closely into the matter, it is apparent that there is no good reason for ceasing to apply more units of labor and capital, simply because the point of diminishing returns has been reached. The seventh unit may be less productive than the sixth, and yet be more productive than any of the first four units. The *average* product per unit of labor and capi-

tal may be greater when seven units have been applied than when only six have been expended. Hence the total product of the thousand units may be greater when seven units have been applied to each acre and only one hundred and forty-three acres of land employed. But at what point shall the farmer cease to increase the application of labor and capital to a single acre? It is obvious that there is a limit to the amount of labor and capital which can be expended profitably upon a given area of land, that a thousand dollars' worth of labor and capital applied to one acre of land in agricultural production would yield a smaller return per unit of labor and capital employed than when more land is used and the number of units applied to each acre more limited. But what is the limit? It is true that in the case before us the sixth unit increases the total product more than any unit before or after it, but all units cannot be *sixth* units. The first, the second, and the third are indispensable: hence it is the *highest average return* which we must keep in mind. The average product per unit increases rapidly until the sixth unit has been employed, and then less rapidly until a point is reached where the slightest increase in the application of labor and capital will not increase the average product; and, because the law of diminishing returns is operating, the application of another unit, however small, will reduce the average product of all units employed.

The thousand units of labor and capital are used in the most productive manner when the acreage is so limited that the number of units applied to each acre is just sufficient to yield the maximum average product per unit. This highest average is attained only when the degree of intensity is such that the final increment of labor and capital applied to each acre produces no more or less than the average. For example, the highest average return is gained by the application of X units in the case before us in Fig. 2, where the location of X is determined by the fact that the rectangle A V X′ X is drawn in such a manner that its area equals the

area A I′ X′ X, which represents the total product of X units of labor and capital. Had the application stopped at I, after the application of only six units, the total product would be represented by area A I′ I, or the rectangle A W N I, and the average return per unit would have been less. Likewise, had the applications been increased to nine units, the average return per unit would have fallen. Hence we may draw a curve of increasing and diminishing *average returns*, based upon the increasing and diminishing returns of successive units. This curve of averages, represented by line A X′ P (Fig. 2) must be so drawn that the distance between the lines A X′ P and A B will at all points be such that the rectangles formed by drawing a line parallel to A B (line W N, for example) through the curve A X′ P at any point will represent the total product when applications have reached the corresponding point on line A B. That part of the rectangle lying between the lines H H′ and I I′, for example, will represent the average return per unit applied up to that point. As illustrated in Fig. 2, the curve of averages reaches the highest point at X′, and the highest average product per unit of labor and capital is gained by employing seven and three-fifths units per acre. After the point X′ is reached, the line of averages, X′ P, falls; for, after X units have been applied, further applications of labor and capital will reduce the average product per unit. Thus, when there is no rent to pay, the application of labor and capital should increase until the point of maximum average returns per unit is reached, and there it should stop. This is the most extensive agriculture that can be profitable under any circumstances, and the most intensive that can be profitable to the farmer where nothing is paid for the use of land.

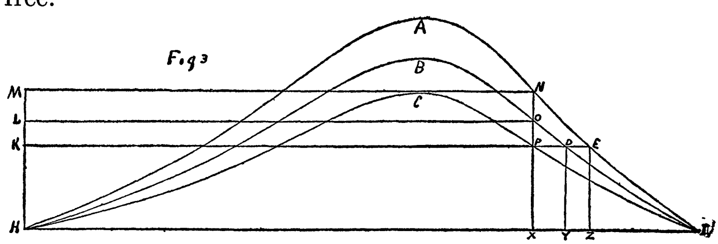
The payment of a *share rent* does not tend to increase the intensity of culture. The share rent increases as the total product increases; and we may think of it as taking some fixed portion, say one-third, of the product of each succeeding unit of labor and capital applied, so that the farmer

gets only two-thirds of the product of each unit, and his share reaches the highest average return per unit with the same degree of intensity which yields the highest average gross return per unit.* Hence, where the share tenants follow their own self-interest, they will farm no more intensively on the best land when poorer grades of land have been resorted to than when only the best grade was cultivated.

But, where fixed rents are paid or where the farmers own the land which they cultivate and count interest on its market value, the better land will be cultivated more and more intensively as poorer and poorer grades of land are brought into cultivation. Suppose that three dollars per acre must be paid. This rent is paid once for all. We may think of it as taking all the product of the first four and one-half, or *r*, units of labor and capital (Fig. 2). The farmer receives no return upon his labor and capital until the rent is paid. Should he cease to apply labor and capital when *r* units have been employed, the product would just pay the rent. Whatever he produces by further applications may be kept as payment for labor, capital, and superior efficiency. In this discussion we shall speak of that share of the product which is left after paying the rent as a net return. When there is no rent to pay, the farmer seeks the highest average *gross* return per unit of labor and capital employed; but, where a fixed rent must be paid, he no longer seeks the highest average *gross* return, but the highest average *net* return. The average net return per unit follows the law of increasing and diminishing returns in the same manner as the average gross return. But, when a fixed rent is paid, the line of increasing average net returns starts at point *r* (Fig. 2); for all of the product of the first four and one-half units is required to pay the rent, and the average *net* return at that point is zero. After the application of five units the average net return per unit will be represented by one-fifth of the area r r′ H′ H. After the

*** This point is capable of mathematical demonstration.**

application of the sixth unit, it will be one-sixth of the area r r′ I′ I. After the application of the seventh unit, the average will be one-seventh of the area r r′ K′ K. Thus the line of average net returns (Line r Y′ T in Fig. 2) rises rapidly until the line I I′ is crossed, after which it rises less rapidly until it crosses line I′ B, after which it falls. When a fixed rent is paid, the line of average *net* returns can never rise so high as the line of average *gross* returns, and the point Y′, where the line of average net returns reaches its maximum distance from the base line A B, will always be farther to the right than point X′; and hence the highest average net return per unit of labor and capital employed on land for which a fixed rent must be paid will be gained by a more intensive culture than when the same land could be had free.



The degree of intensity of culture which will prove most profitable on a given piece of land will vary with the amount of the fixed rent which is paid for its use,—the greater the amount of rent, the higher the degree of intensity.

Suppose that our farmer has three grades of land to choose from. These three grades of land are represented by the letters A, B, and C (Fig. 3), the latter being marginal land. The curves H A I, H B I, and H C I represent the increasing and diminishing returns to succeeding units of labor and capital upon the different grades of land. We have simplified the actual conditions somewhat by taking a case where the lines of increasing and diminishing returns have a definite relation to each other. The largest gross return per unit of labor and capital will be gained from each of

these three pieces of land when X units (measured by line H X, in Fig. 3) have been expended. With this expenditure upon each of the three grades of land, the value of the product which a given farmer can produce on A grade land will be represented by area H M N X; that of B grade land, by the area H L O X; and that of C grade land, by area H K P X. But the same amount of labor and capital will not be applied to the three grades of land. A differential rent will be charged for the better grades, and a more intensive culture will, for this reason, prove profitable. By the time increasing rents on the higher grades of land make it profitable for the farmer to apply X units of labor and capital to C grade land, it would be profitable to apply Y units to B grade land and Z units to A grade land. It is true that these further applications on the better grades of land will not yield a return equal to the highest average *gross* return per unit on these grades of land; yet the average net return will be increased by these extra applications, and all but the final increment will yield a return higher than the maximum average upon C grade or marginal land.

We are now in a position to see more clearly the influence of varying degrees of intensity of culture upon differential rents. In our illustration the surplus which a given farmer can produce on A grade land over what he can produce on C grade land is represented by the area K M N E, which is greater than the area K M N P by the area P N E; but the area K M N P measures the difference in the value of the product which he could produce on the two pieces of land with the same amount of labor and capital. Hence it is not simply differences in productivity with the same outlay, but differences in the capacity of the land to yield a surplus, that determine how much more highly a farmer will estimate one piece of land than another of the same area.*

Variation in productivity is, to be sure, the primary occasion of differential rent; but this rent cannot be *measured*

*Marshall's *Principles of Economics*, 2d ed., p. 214 *et seq.*

in terms of differences in productivity. To the differential arising from variations in productivity under equal applications of labor and capital must be added the differential due to variations in intensity of culture. These together constitute the differential surplus. If all farmers possessed the same degree of efficiency, this differential surplus would represent the differential rent, being the amount which all farmers would as willingly pay for the better land as consent to farm the poorer land. But because of differences in the efficiency of farmers the amount of differential surplus which a given piece of land will yield is not a definite amount, but varies with the efficiency of the farmers; and competition determines what share of the surplus which a given farmer can produce will actually be paid as differential rent. The differential rent of the better grades of land will be greater than the differential surplus which the marginal farmer could produce upon such land, but it will be less than the surplus which the most efficient farmer can produce

With perfect competition the differential rent of any grade of land will be measured by the differential surplus which the marginal farmer could produce upon such land plus the further differential arising from differences in the efficiency of farmers. Hence, instead of a simple differential rent arising from one variable, we find a complex differential resulting from the interaction of three variables,—variation in the productivity of land, in the intensity of culture, and in the efficiency of farmers.

This, to be sure, is not all there is to be said upon the subject of differential rents. The varying conditions are so numerous and so complex that it is next to impossible to make a brief and final statement of the causes and conditions which determine the amount of differential rent that is paid for a given piece of land. Yet it is hoped that by further analysis we may, in time, be able to see more clearly those forces and conditions which regulate the price which is paid for the use of land.

HENRY C. TAYLOR.